U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE AGRICULTURAL AND ECONOMIC GEOLOGICAL SURVEY OF NORTH DAKOTA, PROF. DANIEL E. WILLARD, DIRECTOR.

SOIL SURVEY OF THE CARRINGTON AREA, NORTH DAKOTA.

BY

A. E. KOCHER AND LEWIS A. HURST.

[Advance Sheets—Field Operations of the Bureau of Soils, 1905.]

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1906.

[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the Congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., May 14, 1906.

SIR: In continuance of an understanding with Prof. Daniel E. Willard, director of the agricultural and economic geological survey of North Dakota, cooperation with that office was extended during 1905 to a survey of the Carrington area. The accompanying report covers this work, and I recommend its publication as advance sheets of the Field Operations of the Bureau of Soils for 1905, as provided by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

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SOIL SURVEY OF THE CARRINGTON AREA, NORTH DAKOTA.

By A. E. KOCHER and LEWIS A. HURST.

LOCATION AND BOUNDARIES OF THE AREA.

The Carrington area, comprising parts of Griggs and Foster counties, lies in the east-central part of North Dakota, between meridians 98° and 99° 15′ west longitude and parallels 47° 19′ 34″ and 47° 30′ north latitude. The area is rectangular in shape, extending 12 miles north and south and 60 miles east and west, and contains 460,800 acres, or 720 square miles, of which 432 square miles are within the limits of Foster County and 288 square miles in Griggs County. It embraces townships 145 and 146 north and ranges 58 to 67 west, inclusive.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Agriculture in the Carrington area had its beginning in 1880, when the first permanent settlement was made near the present site of

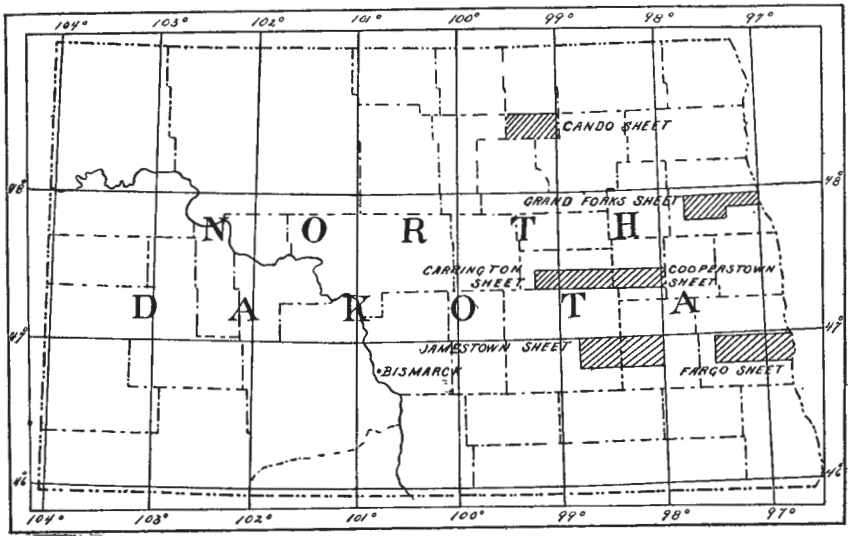

FIG 1.—Sketch map showing location of the Carrington area, North Dakota.

Cooperstown. In 1882, when Griggs County was organized, with Cooperstown as its county seat, many immigrants from southern Michigan settled in the eastern part of the area. The following year settlement was greatly encouraged by the completion of the United

States survey of the public lands and the building of branch lines of the Northern Pacific Railway from Sanborn to Cooperstown and from Jamestown to Carrington. During this year the towns of Carrington and Melville were founded by people from the east.

An industrious class of Norwegians, Danes, and Swedes, a few years later, settled in the region west of Cooperstown, and have been an important factor in the development of the central part of the area.

From the beginning of agricultural operations in Foster County extensive tracts of land have been held by individuals or by private corporations. One of these large holdings, near Bordulac, has an area of 10,000 acres under cultivation. Aside from this, only a small proportion of the public lands west of the James River had been taken up prior to 1896, but during that year and in 1898 many home seekers from Iowa and Indiana came into the area, and most of the unbroken prairie between Carrington and the river was put in cultivation. Also about this time a thrifty class of Turks and Russians settled in the southwestern corner of the area, among the foothills of the Missouri Plateau, and during their brief occupation of the land they have done much to increase the valuation of what was hitherto considered a very inferior soil.

In the early days the farming class was not so prosperous as in succeeding years, owing mainly to the crude and ineffectual methods practiced during the seasons of excessive drought. Since then all farm methods have undergone a material change. The smoothing harrow and the old-fashioned broadcast seeder attached behind a wagon and drawn across the field have been replaced by the spring-tooth harrow and the modern press drill. These implements, it has been found, make the seed-bed firm and conserve the soil moisture better, lessening the damage caused by long periods of drought.

Wheat, flax, and oats, the crops which held first place in the rotation twenty years ago, are still the dominant crops of the area. There is, however, a decided tendency to introduce some new crops. Corn, a needed cereal, is beginning to be grown, and alfalfa, clover, and the tame grasses have been lately introduced with success.

CLIMATE.

The climate of the area is quite varied. In the winter the temperature sometimes falls to 50° below zero, while in the summer it has been recorded as high as 107°, giving an extreme range of 157°. The summer months are usually very pleasant, the temperature rarely rising above 90°, and the nights are usually cool.

The spring and fall months are usually characterized by high winds, which, beginning in the morning, increase in force until about 2 o'clock p. m., then gradually slacken and abate with the setting of the sun.

There is only one Weather Bureau station within the area, which is located at Melville, but for purposes of comparison the records of the Jamestown and Devils Lake stations are also given.

The following table shows the normal monthly and annual temperature and precipitation:

Normal monthly and annual temperature and precipitation.

Month.	Melville.		Devils Lake.		Jamestown.	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	Inches.	°F.	Inches.	°F.	Inches.
January	12.0	0.12	8.0	0 27	9.0	0.50
February	6.0	.12	4.0	.60	9.0	.56
March	26.0	.32	17.0	1.06	19.0	1.00
April	43 0	.85	41.0	.95	42.0	2.21
May	55.0	1.30	52.0	1.68	53.0	2.98
June	62 0	7.30	64.0	3.38	65.0	4.21
July	62.0	2.03	69.0	4.12	70.0	2.24
August	64.0	.20	65.0	2.34	67.0	1.28
September	54.0	1.46	59.0	.57	58.0	.93
October	43.0	2.10	42.0	1.84	46.0	1.89
November	26.0	.20	28.0	.35	22.0	1.15
December	11.0	.25	10.0	.20	16.0	.74
Year	38.8	16.25	38.2	17.36	39.7	19.69

Notwithstanding that the normal annual rainfall is rather light, especially as recorded at the Melville station, the fact that such a large proportion of it comes in the growing season usually makes the amount sufficient for crop production.

According to the records of the above station, one-half of the normal annual precipitation for the last seven years has fallen during the months of May and June, and the total normal precipitation from November 1 to April 1 has been only 1.01 inches. Though these figures are somewhat more striking than those presented by the Devils Lake and Jamestown stations, and may perhaps exaggerate to some extent the conditions in the eastern part of the area, they emphasize the fact that the average snowfall of the region is very light indeed.

From data relating to the dates of the last killing frosts in spring and the first in fall, as afforded by the records of the same Weather Bureau stations, the average date in spring is shown to be May 28 and in fall September 12. The average length of the growing season, based on frost occurrences during the last seven years, was 106 days at Melville and Jamestown and 109 days at Devils Lake.

PHYSIOGRAPHY AND GEOLOGY.

The topographic features of the Carrington area are those characteristic of glaciated regions. Two extensive systems of moraines, extending in a northerly and southerly direction, divide the area

into three distinct and comparatively level tracts. One of these moraines, occurring in the vicinity of Cooperstown, has an average width in the area of about 4 miles, although just before crossing the northern boundary, its course becoming east and west causes it to occupy the northern tier of sections in both Cooperstown and Clearfield townships. In this locality the topography is rough and broken, the hills rising abruptly from the plains to a height of 30 to 100 feet. South of Cooperstown the morainic belt becomes narrower and the hills less pronounced.

East of this region to beyond the limits of the area extends a gently undulating plain, through which the sluggish Sheyenne River crosses the area from north to south. Here the valley, cut in glacial times, has an average width of about one-half mile and lies 100 feet or more below the level prairie. With the exception of one big bend the course of the river in the main is straight, but its feeble current along the level bottom causes it to wind from side to side of the valley. In the southern part of the valley are several old channels marked by sloughs and shallow lakes, through which the river still flows in times of high water.

The second and more important moraine is found just east of the center of Foster County, where it occupies probably 100 square miles of the area. Geologically this region is known as the Fourth or Kiester moraine, and is of interest here in that it forms the high walls of the glacial valley of the James River. Although about equal parts of this moraine lie on each side of the river, yet in surface features they present a striking contrast. East of the river for about 4 miles the country consists of rounded hills and low ridges, separated from each other by gently sloping tracts. The altitude varies from 1,500 to 1,560 feet above sea level and from 20 to 60 feet above the prairie to the east. West of the river the surface of the first 2 miles is rough and broken in the extreme. The elevation varies from 1,520 feet, the level of the prairie, to 1,690 feet near the northern limit of the area. The valley of the river, with an altitude of 1,430 feet, lies about 100 feet below the level of the prairie and 260 feet below the summit of the moraine.

East of the James River, between the two morainic belts already described, there is a gently rolling plain constituting about one-third of the entire area mapped. Near its eastern edge this plain is cut in a southeasterly direction by the deep channel of the Baldhill Creek. At the present time this stream is small and unimportant, but when the glacier's edge stood a few miles to the north, where now the moraine belt is found, a mighty river hurried down its course, cutting out the broad, deep valley with the waters from the ice.

The remaining great physical division of the area extends westward from the moraine along the James River to the foot of the Missouri

Plateau, of which the outlying hills of Hawks Nest just touch the southwestern corner of the area. This broad plain is characterized by a slightly rolling surface, marked in the western part by the intermittent channel of Pipestem Creek, numerous hay meadows, and sloughs.

The entire area during the glacial period was covered by the ice, which on melting left its burden of sand, silt, and clay scattered on the surface. This glacial till or drift varies in the area from 10 to 200 feet or more in depth, and because of the comparatively light rainfall since its deposition the surface features have been but slightly modified. Below the drift there lies a bed of Cretaceous shale, which along the Sheyenne River Valley comes within from 10 to 20 feet of the surface of the prairie. The soils resulting from this formation are very heavy and are considered among the most productive in the area.

SOILS.

Twelve distinct types of soils were recognized and mapped in the Carrington area. The following table shows the name and extent of each:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Marshall silt loam	240,128	50.2	Marshall fine sand	4,096	1.0
Marshall loam	114,560	26.3	Wabash clay	3,328	.9
Clyde loam	24,768	5.5	Hobart clay	2,496	.7
Marshall stony loam	23,936	5.2	Marshall gravelly loam	1,920	.5
Marshall fine sandy loam	21,696	4.9	Wabash loam	1,536	.4
Meadow	16,064	3.2			
Carrington clay loam	6,272	1.2	Total	460,800	

MARSHALL LOAM.

The Marshall loam to an average depth of about 10 inches consists of a dark-brown friable loam, underlain usually by a grayish-brown silty clay, becoming slightly yellow in the lower depths.

The type is found in all parts of the area occupied by moraines and in the level prairie along the courses of the streams. The most extensive body of this type occupies the hills just west and south of Cooperstown and a large portion of the level prairie bordering Baldhill Creek. It also occurs between the areas of Marshall silt loam and Marshall stony loam along the James River and in the vicinity of Pipestem Creek south and west of Carrington.

The level and rolling topography gives rise to slightly different phases of the type. The hilly phase, described above, is the more important by reason of its greater extent. The level phase near Baldhill Creek consists of about 20 inches of dark-brown loam underlain with yellowish-brown fine sandy loam or shaly loam and sand.

The porous subsoil gives the phase adequate subdrainage, which in seasons of slight rainfall is apt to be excessive, while the sloping surface of the hilly phase gives that portion of the type ample surface drainage.

The Marshall loam is of glacial origin, the hilly phase having been deposited along the front of the melting ice. On the prairie near the course of Baldhill Creek the sandy phase is probably a glacial overflow, the deposit being made by the waters hurrying southward at the time when the front of the ice sheet halted in the morainic region a few miles to the north. On the higher elevations, where the finer material has been removed by rains, the soil is shallow and has a relatively high content of fine sand and gravel, but these areas are of very small extent.

Until recently a part of the type was used as pasturage for herds of cattle and sheep, but the stock-raising industry is now confined to the stony hills along James River.

Wheat and flax have always been the leading crops on the Marshall loam, the yields averaging 15 and 12 bushels per acre, respectively. Oats yield from 30 to 60 bushels per acre. Barley, rye, and spelt also do well and are extensively grown, although the last named is but newly introduced. For the growing of potatoes, corn, and garden truck this soil is unexcelled in the area. Potatoes yield from 150 to 250 bushels per acre and are of excellent quality. However, at present this crop is grown only for home consumption. The average yield of corn in favorable seasons is about 40 bushels per acre.

The value of the hilly phase of the type ranges from $15 to $25 an acre, while that of level topography in the more desirable locations sells at from $20 to $30 an acre.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Marshall loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12803, 13405, 13407.	Soil.....	1.8	8.5	6.9	27.3	15.7	27.3	12.2
12804, 13406, 13408.	Subsoil.....	1.9	6.1	4.6	19.3	13.0	29.7	25.1

MARSHALL SILT LOAM.

The soil of the Marshall silt loam to a depth of from 10 to 16 inches consists of a dark-brown to black silt loam, resting upon a yellowish-brown silty clay subsoil, usually several feet in depth.

The Marshall silt loam is by far the most extensive soil type mapped, occupying about one-half of the area surveyed. It occurs in three

large bodies, each broken into by the less extensive types. One of these bodies occupies the level land near Cooperstown, another is found between Baldhill Creek and the hilly region along the James River, and the third occupies the major portion of the prairie west of Bordulac.

The type consists of two closely related phases passing so gradually into each other that no consistent boundary line between them can be drawn. That portion of the type in the eastern part of the survey is a somewhat heavier soil than that found west of the James River. Near Bordulac and in the vicinity of Carrington areas are found where the soil consists of about 14 inches of black silt loam containing a small percentage of fine sand. The subsoil is a silty clay, varying in color from light brown to white. The areas of white, limy subsoil, as a rule, are not quite so productive as are those in which the lime occurs in less amounts.

The Marshall silt loam has usually a level surface. Now and then low swells occur from 10 to 20 feet in height, which give the type a slightly undulating surface, but nowhere is the topography so rough as seriously to interfere with cultivation.

The type usually has sufficient drainage, though for the cultivation of the deeper rooted crops the low-lying level portions of the prairie would be greatly benefited by open ditches or tile drains.

The origin of the Marshall silt loam dates back to glacial times, when the material was deposited by the melting of the ice. Owing to the light rainfall of the region, little evidence is seen of subsequent erosion. Along the edges of deep coulees and on the summits of the hills, where the rains have carried off the finer particles of earth, a little sand is frequently encountered and the silty subsoil comes within a few inches of the surface; but these areas occur in strips too narrow to be represented on the map.

The type retains moisture well and is one of the most valuable soils in the area. In the vicinity of Carrington cultivated lands sell for from $20 to $30 an acre, while in the eastern part of the area cultivated farms command from $26 to $40 an acre.

The Marshall silt loam has been devoted mainly to the growing of small grains, though it is well adapted to a variety of crops. Alfalfa wherever tried has done well, and red clover, timothy, and brome grass have given excellent results.

Wheat, the chief crop grown, yields from 12 to 30 bushels per acre, the average being about 15 bushels. Flax yields from 10 to 16 bushels per acre, oats from 35 to 70 bushels, and barley, rye, and spelt in like proportions.

The following table gives the average results of mechanical analyses of samples of the Marshall silt loam:

Mechanical analyses of Marshall silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12923, 13409, 13411.	Soil.....	1.2	3.5	2.5	10.5	13.3	50.3	18.7
12924, 13410, 13412.	Subsoil.....	1.3	5.0	3.0	11.0	14.0	42.9	22.7

CLYDE LOAM.

The soil of the Clyde loam is of a varying texture, ranging from a dark-brown loam to black clay loam, with an average depth of 10 inches. The subsoil is usually a gray or drab-colored clay to a depth of 30 inches, below which are frequently found thin layers of coarse sand.

A phase of the type of quite common occurrence consists of a black, heavy sandy loam, underlain at from 4 to 10 inches by a sticky white silty clay.

The Clyde loam is of wide distribution throughout the area, occurring as numerous low depressions ranging from a few rods in extent to several hundred acres. The type marks the location of old lake beds, which, lying below the general level of the prairie, are always poorly drained. Around the margin of these old lakes well-marked beaches frequently occur from 5 to 20 feet in height, composed of coarse sand, gravel, and large glacial bowlders. This sandy, wind-blown material has greatly changed the texture of the soil in some of the smaller depressions.

For centuries these lake beds have received the drainage of the surrounding prairie and having no outlets the only avenue for the removal of the waters was by evaporation. Thus the salts held in solution by the waters of the lake were left behind and have collected in the lowest places as a white efflorescence on the surface. However, only rarely is alkali encountered in sufficient quantities to interfere seriously with the growth of native vegetation. The soil is frequently too wet for cultivation, and only about 1 per cent of the type has yet been broken up. Where alkali is found on the cultivated areas, the application of barnyard manure has greatly improved the structure of the soil, allowing the rains to carry the salts into the lower depths beyond the reach of the shallow-rooted crops.

The type in favorable seasons supports a luxuriant growth of native grasses; but if the rains come late in the spring the grasses do not make a vigorous growth, and in some years when ready to be cut for hay many of the areas are so wet as to prevent the harvesting of the crops. The greater part of the land of this type is held at about $15 an acre.

The following table shows the average results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Clyde loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13415, 13417.....	Soil.....	1.0	1.4	1.6	12.4	17.5	42.9	23.1
13416, 13418.....	Subsoil.....	1.2	4.8	4.1	8.9	14.6	38.4	27.9

MARSHALL FINE SAND.

The Marshall fine sand is an incoherent, dark-brown or black fine sand, slightly loamy on account of the presence of organic matter, grading at 12 to 16 inches into a lighter colored, less coherent fine sand, and this in turn, at 24 inches, is underlain by a yellow or gray sand of fine to medium texture.

The type occupies gently rolling prairie land and is primarily glacial in its origin, being deposited by the melting of the glaciers or carried by their waters. Most of the type lies adjacent to or in the vicinity of river courses. The largest bodies were found just west of the Sheyenne River and in T. 146 N., R. 61 W., in the vicinity of Baldhill Creek. A few small bodies are found in other parts of the area.

The soil, on account of its loose texture, is easily transported by the wind, being carried sometimes a considerable distance, and is often found in dunes from 2 to 3 feet in depth. Crops are often materially damaged by these sand storms, which often occur in the spring about the time the young grain is putting forth its tender shoots.

Only a small percentage of the Marshall fine sand is under cultivation. The native vegetation is less vigorous than that of the heavier prairie soils, and, except in very wet seasons, the crop yields are rather poor, ranging from 6 to 8 bushels of flax per acre, 8 to 10 bushels of wheat, and from 20 to 25 bushels of rye, oats, or barley.

The value of this type of soil varies from $15 to $25 an acre, depending upon its location and proximity to the heavier soils of the area.

The following table gives the results of mechanical analyses of typical samples of the soil and subsoil of the Marshall fine sand:

Mechanical analyses of Marshall fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12921.....	Soil.....	0.3	1.8	3.7	52.6	17.7	16.5	7.3
12922.....	Subsoil.....	.3	1.1	3.0	55.3	18.8	13.5	8.1

MARSHALL FINE SANDY LOAM.

The Marshall fine sandy loam, to an average depth of 14 inches, is a dark-brown or black loam or fine sandy loam, the color being due to the presence of organic matter. This is underlain with a yellowish-brown fine sandy loam less coherent in structure, grading at 20 inches or more into a yellow fine to medium sand, extending several feet in depth. Overlying the coarser material of the subsoil is often a thin stratum of shale, which when decomposed contains a small percentage of bluish-gray clay. This is particularly true of the large body of this type in T. 146 N., R. 60 W. The subsoil is also frequently a loam.

The Marshall fine sandy loam usually occurs in small patches, the largest continuous bodies being in T. 146 N., R. 60 W., and R. 61 W. In the former the texture of the soil is coarser than in other parts of the area. Disconnected bodies of the type also occur in T. 146 N., R. 61 W., and R. 62 W., and in the vicinity of the Sheyenne River and Baldhill and Pipestem creeks. Another area, occupying parts of three sections, is found south and west of Melville. The type usually occupies gently undulating prairie or small morainic hills or plateaus. It frequently occurs also in narrow bands encircling old lake beds and along stream courses, but these were not of sufficient extent to be shown on the accompanying map.

The soil is of glacial origin, although the winds may have been a factor in its deposition. In the vicinity of the streams or between them and the series of moraines to the north of the area it is reasonable to suppose that this soil was deposited as overwash from the melting of the ice of the glaciers or carried down by the waters off the moraines themselves.

Owing to the fairly loose structure of both soil and subsoil and location in the vicinity of stream courses and old lake beds, the Marshall fine sandy loam is naturally well drained, but it is sufficiently compact to retain enough moisture to withstand drought. In extreme wet or dry seasons it frequently gives better yields of grain than the heavier types, and the crops are less susceptible to rust, but in average seasons the yield is less. The type is particularly well adapted to Irish potatoes, the yields being from 150 to 250 bushels per acre. Corn also does well on this soil, but is grown only in small gardens for home use. Each of the cereals grown in the area is found upon the Marshall fine sandy loam, with average yields per acre, as follows: Wheat, 10 to 15 bushels; flax, 6 to 10 bushels, and rye, barley, or oats, 25 to 30 bushels.

Land of this type ranges in price from $20 to $30 an acre.

The following table gives the average results of mechanical analyses of typical samples of soil and subsoil of the Marshall fine sandy loam:

Mechanical analyses of Marshall fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12801, 13403.....	Soil.....	1.7	11.1	9.1	28.3	17.2	21.1	11.2
12802, 13404.....	Subsoil.....	.6	5.7	7.8	27.0	15.4	32.1	11.1

WABASH CLAY.

The soil of the Wabash clay consists of a dark-brown or black clay loam or clay, with an average depth of about 12 inches. The subsoil is usually a black heavy clay, from 12 to 30 inches deep, underlain to a considerable depth by a light-brown clay of the same texture. The soil is tenacious and rather difficult to work, especially in the spring, when it is often saturated by the seepage waters from the higher levels.

The Wabash clay, averaging one-half mile in width, is found along the lowest portions of the Sheyenne River Valley. In the northern part of the valley, where the type lies chiefly on the eastern side of the river, there is a gentle slope from the higher elevation to the water's edge, but farther south, where the strip becomes more narrow and follows more nearly the river's course, the surface is quite low and level. In this level portion, where the water sometimes saturates the soil, open ditches could be dug or tile drains laid with profit. The greater part of the type, however, is well drained and under a fair state of cultivation.

The Wabash clay is of alluvial origin, having been formed by the deposition of the fine particles washed down from the heavy Hobart clay of the adjoining hillsides.

The heavy texture of the soil and its low-lying position along the river, insuring sufficient soil moisture for crops to withstand drought, make the type admirably adapted to small grains and tame grasses, although the latter have not yet been extensively introduced. Wheat, under favorable conditions, yields from 20 to 35 bushels per acre, oats from 35 to 70 bushels, and flax, rye, and barley do remarkably well.

Along the course of the river and the old glacial channels which wind through the valley, occurs a narrow strip covered by a dense growth of oak, ash, and elm. This growing timber, in a region where fuel is so scarce, makes this type of soil one of the most valuable in the area, and because the valley is so badly broken into by the tortuous channel of the river, this portion of the type is probably more valuable in its present state than it could possibly be under cultivation.

The price of the land ranges from $30 to $40 an acre, depending upon improvements.

The following table shows the average results of mechanical analyses of samples of the Wabash clay:

Mechanical analyses of Wabash clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13000, 13421.....	Soil.....	0.2	1.3	1.2	5.6	6.7	48.2	36.3
13001, 13422.....	Subsoil.....	.1	1.1	.8	3.2	4.4	35.1	55.1

HOBART CLAY.

The Hobart clay, though small in extent, may be said to have three distinct phases, depending upon the declivity of the bluffs along which it occurs.

At the top of the bluff the soil consists of from 0 to 6 inches of brown clay loam, underlain to about 4 feet by dark-drab or slate-colored clay. Along the steeper part of the hill and that portion of the valley where erosion has been most active the clay loam has been entirely washed away, leaving the stiff, waxy, slate-colored clay exposed. At about the fourth foot the subsoil begins to pass gradually into shale, which soon gives place to the unweathered Cretaceous rock. On this phase of the type the surface is usually thickly strewn with large glacial bowlders. Nearer the valley, where the slope is more gentle, the soil consists of about 10 inches of friable clay loam, underlain to a considerable depth by black plastic clay.

The Hobart clay occurs along the precipitous bluffs of the Sheyenne River and the steep-sided coulees leading into it. Of the eroded phase the most typically developed area is found 5½ miles southeast of Cooperstown, where the slippery clay and decomposing shale slide down the hill with every heavy rain, leaving the surface devoid of any vegetation.

Owing to its position, the stiff, waxy nature of the soil, and the numerous glacial bowlders scattered over the surface, only that phase of the type which occupies the lower portion of the hill can be used for cultivation. Such a strip occurs near the northern boundary of the area on the east side of the river, and fine yields of all the small grains are annually produced. Where the Hobart clay is under cultivation the land is held at about $30 an acre, but the greater part of the type, used only for pasture, is valued at from $10 to $15 an acre.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of Hobart clay:

Mechanical analyses of Hobart clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13026, 13395.....	Soil.....	2.9	6.9	3.9	12.4	4.4	30.9	38.4
13027, 13396.....	Subsoil.....	1.4	4.9	2.1	4.1	1.9	17.4	67.8

WABASH LOAM.

The Wabash loam, from 0 to 7 inches, consists of a dark-brown friable loam, with a considerable admixture of fine sand and silt, underlain by a subsoil usually of the same texture and color as the soil, but becoming somewhat lighter in color below the second foot.

Only a few small areas of Wabash loam were encountered, these occurring as narrow strips within the Sheyenne River Valley. The type occupies the more gently sloping portions of the valley and is an intermediate type between the Marshall stony loam of the bluffs and the Wabash clay of the valley floor. On the outer bends of the river, where the stream approaches the sides of the valley, the type extends down the slope to the bank of the stream, the elevation ranging from 5 to 30 feet above the high-water mark.

The Wabash loam is one of the best drained soils in the area, and yet rarely suffers from the effect of drought. The type has been formed from the materials washed down from the Marshall stony loam and the prairie types adjoining. The soil is of comparatively recent origin, and owing to its position is constantly undergoing change, as the rains bring down materials from the bluffs or carry away materials previously deposited.

The Wabash loam is a very productive soil, and because of its excellent drainage features and the ease with which it can be cultivated it is well adapted to the production of truck crops. However, owing to the lack of convenient markets, no attempt has yet been made to grow these crops, except as they may be needed for family use.

Practically all of the type is cultivated to the small grain crops. Wheat yields from 18 to 25 bushels per acre, though in exceptional years as high as 35 bushels have been reported. Oats produce from 35 to 65 bushels per acre, and the other grains in like proportion. The type is valued at $30 an acre.

The following table shows the results of mechanical analyses of the Wabash loam:

Mechanical analyses of Wabash loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13419.....	Soil.....	0.8	2.9	1.4	12.1	13.6	40.9	28.2
13420.....	Subsoil.....	.8	2.9	1.3	11.7	13.7	38.3	31.2

CARRINGTON CLAY LOAM.

The Carrington clay loam in its lowest lying phase consists of from 0 to 10 inches of dark-brown to black clay loam, underlain to 40 inches with yellowish-brown silty and sometimes sandy clay. Below this depth the material is a brownish-yellow clay, with an occasional thin layer of coarse sand. This phase of the type occupies the narrow valley of Pipestem Creek and the hay sloughs in the western part of

the area. Its origin is largely sedimentary, the material having been left by the waters of the stream or deposited as beds of former lakes.

The upland or prairie phase of the Carrington clay loam is a brownish-yellow silty clay with an average depth of about 10 inches. The subsoil ranges from material of the same texture and color to stiff, tenacious dark-gray clay. Between the third and fifth foot strata of reddish-yellow sand are frequently encountered, containing varying quantities of calcium carbonate, gypsum, and iron sulphate. The soil when wet is sticky and plastic and presents all of the objectionable features of "gumbo," making it a difficult soil to till.

The type is of comparatively limited extent, being found only in small bodies in townships 145 and 146 north and ranges 66 and 67 west, inclusive. South of Carrington, along the Devils Lake branch of the Northern Pacific Railway, occurs the most typical area of the prairie phase of the type. Here small irregular areas are frequently found from which the original prairie sod has been removed. This condition is commonly believed to have been caused by early prairie fires, and although it may be due to other causes there was not time to investigate this question sufficiently to determine the point definitely. On most of these areas a new sod has been developed, but the vegetation makes a feeble growth at best.

The Carrington clay loam is the only soil in the area seriously affected with alkali. Practically all of the type contains some salts, though not in sufficient quantity to interfere seriously with the growth of native grasses. Only about 1 per cent of the type is under cultivation, and in the cultivated fields small places are occasionally found, ranging from a few rods across to 2 or 3 acres in extent, where the alkali has risen and formed a white crust on the surface. On such spots vegetation has been entirely killed out.

The most effective way to correct permanently the alkali conditions in this soil is by the construction of an artificial drainage system. Deep open ditches are a necessity, as the structure of the soil is such as to preclude the probability of satisfactory results by the use of tile drains. The structure of this soil has in many instances been much improved by the application of barnyard manure, the injurious effects of the alkali having disappeared and the soil made to produce good yields of grain the second season following manurial treatment.

This type of soil is valued at from $9 to $15 an acre.

The following table shows the average results of mechanical analyses of samples of this soil:

Mechanical analyses of Carrington clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13386, 13389, 13392.	Soil.....	1.3	3.2	3.6	13.6	15.4	31.4	31.0
13387, 13390, 13393.	Subsoil.....	.9	2.8	3.5	15.7	19.1	31.0	26

MARSHALL GRAVELLY LOAM.

The Marshall gravelly loam contains a high percentage of rounded quartz and granitic gravel, ranging from one-half inch to 2 inches in diameter. The interstitial material usually consists of coarse sand and incoherent shale, which, at a depth of 3 feet, give place to a yellow silty loam.

The type is found only in small areas on the summits of the higher hills and ridges. The largest of these areas, which does not much exceed 1 square mile in extent, occurs northwest of Cooperstown in portions of sections 5 and 6 of T. 146 N., R. 60 W.

Owing to its rough topography and the loose texture of the soil, the Marshall gravelly loam is little used for cultivation. However, on a few of the lower ridges fair yields of the smaller grains are sometimes secured. The value of the type ranges from $10 to $15 an acre.

The following table gives the results of mechanical analyses of samples of the Marshall gravelly loam:

Mechanical analyses of Marshall gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13399	Soil	6.6	28.3	10.1	19.0	7.1	14.4	14.3
13400	Subsoil	9.5	24.5	9.5	13.5	8.3	19.1	15.6

MARSHALL STONY LOAM.

The soil of the Marshall stony loam is usually a dark-brown fine sandy loam or loam, with an average depth of about 10 inches. The subsoil of the greater part of the type consists of a light-brown silty loam or silty clay, reaching many feet in depth.

Scattered over the surface and sometimes deeply embedded in the soil are found numerous granitic glacial bowlders, ranging from a few inches to 10 feet or more in diameter. In some localities, where the rains have washed the finer soil away, the bowlders have been left as a virtual pavement over the surface of the ground and only sand and gravel occupy the interstitial spaces.

Though the type is found in small, irregular patches throughout the survey, only two areas of very large extent were mapped. The largest of these occurs along the banks of the James River, occupying the greater proportion of the high morainic hills. In this locality small areas are found on which few stones occur, but these, being of rough topography and small in extent, were mapped as a part of the more stony phase of the type. The next most extensive area occupies the foothills of the Missouri Plateau, in the southwestern corner of Foster County. Small areas occur along the bluffs of the Sheyenne River and among the moraines just west of Cooperstown.

The surface of the Marshall stony loam is naturally very rough and broken, a common feature being the frequent occurrence of "hay sloughs" surrounded by irregular hills. Much of the soil has excessive drainage, as the slight rainfall, instead of being retained on the steep hillsides, quickly runs off and is lost in the heavier soils of the depressions.

The origin of the type is purely glacial, the high moraines and long, smooth swells and ridges marking the place where the edge of the melting ice sheet halted in its slow retreat across the area.

One phase of the Marshall stony loam consists of large stones embedded in coarse sand and fine gravel. This phase occupies the summits of the higher hills or occurs as narrow strips around the margins of old lakes. In either case it has no agricultural value. In a few instances, where the stones appear only on the surface, the owner has removed them, and when this is done the soil is fairly productive. However, only a small per cent of the Marshall stony loam is under cultivation, it being considered more profitable to utilize the type for grazing purposes than to attempt cultivation, which can only be done after removing the stones.

Along the James River the hills support at nominal cost throughout the summer a herd of several hundred cattle, and a considerable income is realized by some of the farmers from the cattle industry.

The value of the Marshall stony loam varies from $8 to $15 an acre, depending upon location and topography.

The following table gives the results of mechanical analyses of typical samples of the Marshall stony loam:

Mechanical analyses of Marshall stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13397.....	Soil.....	7.7	12.8	7.3	19.4	14.7	24.3	13.9
13398.....	Subsoil.....	4.7	11.8	7.4	18.3	15.0	23.5	19.3

MEADOW.

Meadow is composed largely of coarse sand, underlain at varying depths with gravel, shale, and cobblestones. In some localities the soil contains a small amount of silt and clay, overlying always a subsoil of loose texture.

The type occurs in small irregular areas along the present courses of the streams and the unused waterways of glacial times.

Along the James River, near the northern boundary of the area, occurs about 1,600 acres of the type, of which nearly one-half has been put in cultivation. During wet seasons fair crops of grain are produced, but the frequent occurrence of large, glacial bowlders on the

surface interferes to a great extent with cultivation. From this body down through the valley extends a narrow strip, in which occur a few small areas of very desirable soils, adapted to the usual crops grown, but these were of too small extent to be classified as a new type.

In the southwestern part of the area another extensive body of Meadow is found deposited as glacial wash on the more gentle slope at the foot of the Missouri Plateau. Here the loamy material, from 10 to 15 inches deep, gives the type the appearance of good, productive soil, but the underlying gravel and cobblestones make it very susceptible to the effects of drought.

The type, whether cultivated or used for pasture, is valued at from $10 to $15 an acre.

The following table shows the results of mechanical analyses of samples of the Meadow:

Mechanical analyses of Meadow.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13022	Soil	3.2	30.6	20.6	14.3	4.3	11.3	15.1
13023	Subsoil	9.2	43.0	25.9	13.3	.9	2.4	5.2

ALKALI IN SOILS.

Alkali in injurious quantities was found only in the southwestern part of the area. The small bodies of Carrington clay loam, which occur south and west of Carrington, are all more or less impregnated with alkali, though this is the only soil in the area which is seriously affected. Only portions of these bodies contain alkali in sufficient quantities to prevent the growing of ordinary crops. These strongly impregnated spots, occurring usually in the center and lowest portions of the type, vary in size from a few rods across to 2 or 3 acres in extent, and are commonly marked either by badly stunted crops or by the entire absence of vegetation.

Samples of the soil and subsoil were taken from the worst alkali areas, and the character and quantity of the salts present determined in the chemical laboratory of the Bureau. The results of the analyses, given here in tabular form, show that the salt content in these areas is sufficiently high to interfere with the growth of ordinary crops. The principal salt found is sodium sulphate, although there are also present considerable quantities of sodium carbonate, a salt especially harmful to plant growth. The total area sufficiently affected by alkali to prohibit plant growth probably would not exceed 300 acres.

Although these analyses indicate the presence of excessive quantities of injurious salts, the areas so affected were so few and of such small extent that the construction of a special alkali map for the area was not deemed advisable.

Chemical analyses of alkali soils.

Constituent.	Number 13387, subsoil of 13386, 10 to 36 inches.	Number 13388, subsoil of 13386, 36 to 60 inches.	Number 13390, subsoil of 13389, 10 to 40 inches.	Number 13391, subsoil of 13389, 40 to 60 inches.	Number 13392, soil 0 to 10 inches.	Number 13393, subsoil of 13392, 10 to 40 inches.	Number 13394, subsoil of 13392, 40 to 60 inches.
Ions:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Calcium (Ca)	1.95	0.62	2.14	1.21	.....	0.52	.....
Magnesium (Mg)	2.21	4.96	.....	3.12	1.39	1.31	4.31
Sodium (Na)	23.47	17.36	24.64	24.78	27.33	27.71	18.10
Potassium (K)	2.43	6.61	5.00	1.04	1.78	1.05	7.33
Sulphuric acid (SO_4)	45 82	45.45	42.15	54.77	38.41	50.98	29.75
Bicarbonic acid (HCO_3)	24.12	25.00	26.07	12.65	28.71	18.43	36.63
Chlorine (Cl)	.....	.....	.....	2.43	.....	.....	.....
Carbonic acid (CO_3)	.....	.....	.....	.....	2.38	.....	3.88
Conventional combinations:							
Calcium sulphate ($CaSO_4$)	6.42	2 07	6.79	4.15	.....	1.96	.....
Magnesium sulphate ($MgSO_4$)	10.62	24.17	.....	15.57	7.33	6.54	22.31
Sodium su'phate (Na_2SO_4)	48.66	36.58	55.35	57.44	48 32	65.60	17.60
Sodium bicarbonate ($NaHCO_3$)	27.88	20.24	24.64	14.71	39.60	23.16	45.49
Potassium bicarbonate ($KHCO_3$)	6.42	16.94	13.22	2 94	.....	2.74	5.58
Sodium chloride (NaCl)	.....	.....	.....	5 19	.....	.....	.....
Sodium carbonate (Na_2CO_3)	.....	.....	.....	.....	1.78	.....	.....
Potassium carbonate (K_2CO_3)	.....	.....	.....	.....	2.97	.....	9.02
Per cent soluble	.45	.48	.28	.58	.51	.77	.23

AGRICULTURAL METHODS.

Since the beginning of agriculture in the area the principal crops have been wheat, flax, oats, and barley, and as all of these, excepting flax, are sown early in the spring, the short period between the thawing of the soil and the time for seeding makes it necessary to do much of the plowing in the fall. In the spring it is customary to go over the ground with a disk and a smoothing harrow, after which the field is seeded with a press or shoe drill. Thrashing is done almost entirely from the field, the grain being at once delivered at the elevator, or, in some cases, held on the farm to await shipment later.

As yet no systematic rotation of crops has been established. One of the best rotations, according to some of the most progressive farmers, is wheat two years, followed by barley, flax, rye, and oats.

During the last three years winter rye has been grown by some with much success, the practice being to drill it into the flax or oat stubble in the fall without replowing, or into wheat stubble where the ground was prepared late the spring preceding. Thus the young grain during the winter receives the protection afforded by the snow, which, lodging in the stubble, is not blown away. By this practice larger yields are obtained than from the spring seedings and the crop is harvested in time to permit of summer plowing, thus eliminating the loss occasioned by an idle field during the entire season.

Too little attention is given to the manurial requirements of the land, and the injurious practice of growing wheat after wheat without returning anything to the soil is plainly noticeable on some of the older fields in the area. During the first few years after breaking the rich prairie sod the natural store of decaying organic matter is ample for crop production, but as cultivation continues and this humus is removed something must be added to take its place. This may not now appear essential, for the country is yet new and much of the soil still retains its original productive power, but the experience of the past has taught the wisdom of husbanding the resources of the soil rather than restoring them after it has deteriorated. The best and cheapest fertilizer for maintaining the productiveness of the soils of this area is well-rotted barnyard manure. Especially is this needed on some of the lighter soils, from which much of the organic matter has already disappeared. Care should be taken, however, to have the manure decomposed, lest the coarse litter make the soil too loose to retain sufficient moisture during periods of excessive drought.

AGRICULTURAL CONDITIONS.

The interests of Griggs and Foster counties are distinctly and exclusively agricultural. From one end of the area to the other, a distance of 60 miles, the energies of the people are directed toward the production of small grains. Except among the hills along the James River and the region south and west of Carrington, where settlement has been more recent, the farms are characterized by modern dwellings and large, commodious barns. Public roads have been laid out around every section in the area, and during the last few years considerable attention has been given to their improvement. The work horses are large and serviceable, and the farm machinery of the latest improved type. Improved breeds of cattle have been introduced, and on every hand are evidences of industry and thrift.

The prosperity of the region is strikingly shown by the rapid increase in the value of the lands. Ten years ago, in the vicinity of Cooperstown, unbroken prairie land could be bought at from $5 to $8 an acre, and improved farm land at from $10 to $12 an acre. Now what little remains of the unbroken prairie sells for from $15 to $26 an acre, while improved lands command from $25 to $40 an acre. While in Foster County land values have steadily increased, they have not yet quite reached those in the eastern part of the area. In Foster County, within the limits of the area mapped, are 14,000 acres held by the State as school land, of which the average price is $11.50 an acre. Improved lands in Foster County are valued at from $20 to $30 an acre.

Only a small proportion of the land is occupied by tenants, who, as a rule, are intelligent and industrious farmers. According to the cen-

sus of 1900, 73 per cent of the farms in Griggs County and 77.5 per cent of the farms in Foster County are operated by the owners. Since then, it is generally conceded, the tenant class has been getting smaller, due mainly to the fact that many of this class are acquiring farms of their own. The farms are rented on what is known as the crop-payment plan, by which the owner, furnishing one-half the seed and paying one-half the thrashing bill, receives one-half of the crop, or, furnishing nothing but the land, receives one-fourth of the grain delivered at the elevator.

Although there is a tendency toward smaller farms and better cultivation, there are still a few large holdings in the area. One of these near Bordulac is said to contain 16,000 acres, of which 10,000 acres are in a fair state of cultivation. There are many farms of from 600 to 2,000 acres. The census of 1900 gives the average size farm for Griggs and Foster counties as 427.6 and 437.9 acres, respectively.

The chief problem confronting the farmers of the area is that of securing efficient labor during the busy season of the year. Even the smaller farmers at such time are compelled to hire at least one man. Usually the wage for harvest hands ranges from $1.75 to $2.75 a day and board. While the hired laborers at this season are mostly of the transient class, they are more efficient than were those with whom the farmer dealt ten years ago. Only a few of the wealthier farmers are obliged to hire help the year round. These pay on an average about $20 a month and board. The greater number hire on what is known as the eight months' plan, from April 1 to December 1, paying from $20 to $30 a month and board. Many of this class of laborers soon acquire homes in the locality where they work.

Until recently all of the hay has been obtained from the wild grasses of the prairie and the coarse material of the sloughs. While the hay thus secured is nutritious, it does not equal that obtained from the meadows of tame grasses, and as nearly all the prairies are now broken up and the weeds are crowding out the wild hay in the sloughs the cultivated grasses are being slowly introduced to take its place.

Since the drought of the early eighties the area has been comparatively free from the ravages of pests which have damaged the crops in other regions. In 1904, however, the black stem rust appeared, which caused an estimated loss in Foster County of at least 15 per cent in the common varieties of spring wheat grown, and in Griggs County the loss in yield of these varieties was variously estimated from 25 to 50 per cent of the entire crop. Though the disease may not occur again in several years, this experience should teach the farmer to be on the alert to adopt a practice which, in case it should return, will prevent serious loss. The black stem rust[a] of wheat may exist

[a] Lessons from the Grain Rust Epidemic of 1904. Farmers' Bulletin No. 129, by Mark Alfred Carleton.

in two stages. The first, known as the red-rust stage, causes little if any damage to the crops. The second stage, known as the black rust, causes the shrinkage of the grain, and hence the damage. It is sometimes possible by careful cultivation and the selection of the early varieties for seed to have the grain ripen before the worst attack of the black-rust stage is encountered. It has been found that the durum varieties are without doubt the most rust-resistant wheats now grown. Among these varieties the Iumillo, Velvet Don, and Arnautka are said to take the lead. Although the price ranges from 12 to 15 per cent below that of the common varieties, the fact that the average yield is 20 per cent more makes them valuable varieties to grow.

From the beginning flax has been considered one of the most profitable crops grown in the area. This is due in part to the fact that a good crop can be secured on the newly broken prairie with much less tillage than the other crops demand. It is, however, so exhausting to the soil that it is never wise to attempt to grow two crops in succession on the same piece of land, but they should be placed as far apart as possible in the rotation practiced on the farm. During the last few years this practice has been necessitated by the appearance of a disease known as flax wilt, which materially affects the yield of the crop if grown on the same field two or more years in succession. For this reason, and because so much of the original prairie is already broken up, leaving no new land available for flax, the acreage of the crop during the last few years has been materially decreased.

In the greater part of the area only the seed of the plant is utilized. However, tow mills have been established at Cooperstown and at Kensal for working up the straw into upholstering material; but the price paid for straw—$2 per ton—is so small that only the near-by farmers find it profitable to deliver it to the mill.

All through the area there is an apparent lack of appreciation of the adaptation of soils to crops, and in the past the economy of the farm has been characterized by the struggle to cultivate the greatest acreage of grain without regard to the quality of the land. Timothy, brome grass, alfalfa, and red clover all do well, though as yet little experience has been had in their cultivation. More live stock should be raised and more alfalfa grown. The Marshall silt loam, where good subdrainage can be had, is well adapted to the growing of alfalfa. Corn, while not always a success, is succeeding better every year, and it is thought that within a few years, as a result of the work of acclimation, this crop can be grown with a fair degree of success. During the past year a number of the more hardy fruit trees have been introduced, but the growing of orchard fruits is still in the experimental stage.

Excepting the western part of Griggs and the eastern part of Foster County, the transportation facilities of the area are good. Carrington,

the principal shipping point of the western part of the area, is located at the junction of the Devils Lake and Sykeston branches of the Northern Pacific Railway, connection being made with the main line at Jamestown. Through Carrington also passes the main line of the Minneapolis, St. Paul and Sault Ste. Marie Railway, forming a direct route to both the Northwest and the cities of the East. The Cooperstown branch, leaving the main line of the Northern Pacific at Sanborn and passing north through Cooperstown, gives excellent transportation facilities to the eastern part of the area. These railway lines place the area within easy reach of the great grain markets of Minneapolis, St. Paul, Superior, and Duluth.

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U. S. DEPT. OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF.

SOIL MAP
NORTH DAKOTA
CARRINGTON SHEET.

AGRICULTURAL AND ECONOMIC
GEOLOGICAL SURVEY OF NORTH DAKOTA
DANIEL E. WILLARD, DIRECTOR.

SOIL PROFILE
(3 feet deep)

Marshall stony loam — Sms, Sic
Marshall gravelly loam — Sm
Marshall fine sand — Sc, S
Marshall fine sandy loam — Sc, Sms
Marshall loam — Sc, Sl
Marshall silt loam — Sic, Sl
Carrington clay loam — Scc, Sl
Clyde loam — Sc, C, S

LEGEND

Sms Fine sandy loam
Sic Silt loam
Sm Sand & gravel
S Fine sand
Sc Loam
Sl Silty clay
Scc Clay loam
C Clay

R. 67 W. R. 66 W. R. 65 W. R. 64 W. R. 63 W. R. 62 W.

T. 146 N. — BOTTINEAU CO. LINE
T. 145 N. — WELLS CO.
T. 146 N. — FOSTER CO.
T. 145 N. — STUTSMAN CO.

Minneapolis, Sault Ste. Marie & Atlantic Ry.
St. Paul, Minneapolis & Manitoba Ry.
Chicago, Milwaukee & St. Paul Ry.
Northern Pacific Ry.
Aberdeen, Jamestown & Northern Ry.
Sykeston Branch Northern Pacific Ry.

CARRINGTON
Bordulac
Melville
LAKE GEORGE
Kelly Creek
James River
Turtle River
Crystal Creek

BOUNDARY LINE

LEGEND

Msl Marshall stony loam
Mg Marshall gravelly loam
Mf Marshall fine sand
Sl Marshall fine sandy loam
Ml Marshall loam
Ms Marshall silt loam
Cc Carrington clay loam
Cl Clyde loam
M Meadow

Soils surveyed by
A. E. Kocher and Lewis A. Hurst.
1905.

Scale 1 inch = 1 mile

Field Operations
Bureau of Soils
1905.

U.S. DEPT OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF.

SOIL MAP
NORTH DAKOTA
COOPERSTOWN SHEET.

AGRICULTURAL AND ECONOMIC
GEOLOGICAL SURVEY OF NORTH DAKOTA
DANIEL E. WILLARD, DIRECTOR.

SOIL PROFILE
(3 feet deep)

Marshall stony loam — Sac/f, Sic
Marshall silt loam — Sic, Si/c
Marshall gravelly loam — Sa/gr
Wabash loam — Sc, Sc
Marshall fine sand — S/f, S/m, S
Wabash clay — Scc, Hc, Hc
Marshall fine sandy loam — Sc, Sac/f, S/f
Clyde loam — Sc, C, S
Marshall loam — Sc, Si/c
Hobart clay — Scc, C

LEGEND

Sac/f	Fine sandy loam
Sic	Silt loam
Sa/gr	Sand & gravel
S/f	Fine sand
S	Sand
Sc	Loam
Si/c	Silty clay
C	Clay
Scc	Clay loam
Hc	Heavy clay

R. 61 W. R. 60 W. R. 59 W. R. 58 W.

T. 146 N. BOUNDARY LINE — T. 146 N. STEELE GRIGGS

T. 145 N. FOSTER GRIGGS — T. 145 N. BOUNDARY LINE

CO. CO. CO. CO.

GRIGGS BARNES

Baldhill Creek

Sheyenne River

NORTHERN PACIFIC RY. (SANBORN, COOPERSTOWN AND TURTLE MOUNTAIN BRANCH)

Cooperstown

SHEPARD

Soils surveyed by
A. E. Kocher and Lewis A. Hurst.
1905.

Scale 1 inch = 1 mile

A. Hoen & Co. Lith. Baltimore, Md.

Field Operations
Bureau of Soils
1905.

LEGEND

Msl — Marshall stony loam
Mg — Marshall gravelly loam
Mf — Marshall fine sand
Sl — Marshall fine sandy loam
Ml — Marshall loam
Ms — Marshall silt loam
Wl — Wabash loam
Wc — Wabash clay
Cl — Clyde loam
Hc — Hobart clay
M — Meadow